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Nutrient Content in Leaves of Shoot Bearing Healthy and Malformed Panicle under High Density Mango Orchard (*Mangifera indica* L.) cv Amrapali as Influenced by Organic and Inorganic Sources of Nutrients

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ABSTRACT

A two-year field trial was conducted from 2012-13 and 2013-14 at Horticulture Complex, Maharajpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). Application 520: 160: 450 NPK g plant^{-1} and Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + TV + PSB (100g each) registered higher concentration of N (2.59 and 2.78%), K (62.90 and 77.82 mg kg^{-1}), Zn (27.33 and 230.03mg kg^{-1}), Cu (9.53 and 10.51 mg kg^{-1}), Fe (196.93 and 213.10 mg kg^{-1}) and Mn (88.57 and 98.03 mg kg^{-1}) was in leaves of shoot bearing malformed panicle than healthy once. Whereas, higher concentration of P (0.37 and 0.34%) was in leaves of shoots bearing healthy panicle. Similarly, higher dry accumulation was with malformed panicles over healthy one. The minimum severity and intensity (1.8m^2 and 9.42%) of malformed panicle was noted when plant nourished with 100% RDF of chemical fertilizer (415: 130: 360 NPK g plant^{-1}) or (2.2m^2 and 12.15%) organic sources of nutrient (Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + TV + PSB (100g each) or its combination registered (1.2m^2 and 5.56%).

Keywords: Mycorrhiza (VAM), *Trichoderma viridi*, Azotobacter, Vermicompost, malformation

Mango covers 2.50 million hectares of area with a total production of 18.0 million tonnes, which works out to a low average productivity of 7.2 metric tonnes per hectare (Anonymous 2013). Malformation is one of the most serious disorders of mango causing heavy losses in yield and fruit quality. Of the two types of malformation i.e. vegetative and floral malformation causes heavy losses in yield and is characterized by a condensed mass of flower bud (Singh and Dhillon 1990). However, the exact cause and control of this malady are not clearly understood so far. Recently, Pandey *et al*. (2002) reported that multiple buds produced high proportion of malformation as compared to simple bud in mango cvs. Amrapali and Dashehari. An inadequate nutrition and indiscriminate use of chemical fertilizers and neglecting the use of organic and bio agents paved the way for deterioration of soil health and productivities of trees. The deficiency of nitrogen (Chattopadhya and Nandi 1978), potassium (Mishra 1976) and certain micronutrients has been reported to be responsible for causing malformation. Nutrient refers to those entire compounds, which are required by the plant as a source of body building material energy, without which it will not be able to complete its life cycle. The fruit tree nutrition is concerned with the provision of plant with nutrients as well as nutrient uptake and their distribution in the different organs of the plant. The maintenance of soil and plant health as well as harvest of optimum yield of quality fruits, it is essential to adopt integrated nutrient management (INM) approach. This can be achieved by inclusion of organic manures like FYM, vermicompost, bio agents, oil cake in addition to inorganic fertilizers in nutrient supply system.

Manures are plant and animal wastes that are used as a source of nutrients and released plant nutrient after their decomposition. Therefore, a suitable approach needs to be too identified. The various sources and their interaction in order to get relief from the problems particularly malformation were studied in high density orcharding of mango.

MATERIALS AND METHODS

A field experiment was conducted at Horticulture Complex, JNKVV during 2012-13 and 2013-14. Six year old uniformed plant of cv. Amrapali spaced at 2.5 × 2.5 m and maintained under recommended practices except the treatments were taken for the study. The trial was conducted in a randomized block design with three replications. The soil of experimental site was clay in texture (58.4% clay, 21.5 silt and 20.1% sand) having pH 7.4, electric conductivity (0.25 dSm^{-1}), bulk density (1.48 Mg m^{-3}) medium available N(230.7 kg ha^{-1}), low in P (12.6 kg ha^{-1}) medium in K (340.2kg ha^{-1}) and low in organic carbon (0.47%). The experiment consisted of four levels of chemical fertilizers (F_1: Without fertilizer, F_2: 310: 100: 270 NPK g $plant^{-1}$ (75% of RDF), F_3: 415: 130: 360 NPK g $plant^{-1}$ (100% of RDF) and F_4: 520: 160: 450 NPK g $plant^{-1}$ (125% of RDF) and six organic sources O_1: Oil cake (2.5 kg), O_2: Azotobacter + VAM + TV + PSB (100g each), O_3: Vermicompost (25 kg), O_4: Vermicompost (25 kg) + Oil cake (2.5 kg), O_5: Vermicompost (25 kg) + Azotobacter + VAM + TV + PSB (100g $plant^{-1}$ each), O_6: Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + TV + PSB (100g each) were applied in 39th and 44th metrological week of 2012 and 2013, respectively. A leaves of ten shoots bearing healthy and malformed panicles were detached separately from nodes for recording fresh weight. To determine the dry weight, these leaves were chopped and over dried at 60 ±2°C till get constant weight. The content of nitrogen (Mc Donald 1978), phosphorus (Koenig and Jhonson 1942), potassium (Hanwey and Hindal, 1952) and micronutrient were determined by Absorption Spectrometer (Lu and Chacko, 2000) in leaves of shoot bearing healthy and malformed panicle separately during both the years.

RESULTS AND DISCUSSION

Severity, intensity and dry matter accumulation

Data reveal higher fresh and dry weight was observed with malformed panicle over healthy one under application of nutrients either in the form of chemical fertilizers or organic sources. The fresh and dry weight of malformed panicles (102.1 and 41.5g) was observed respectively with 125% of RDF (520:160:450g NPK $plant^{-1}$). Whereas, recommended dose of chemical fertilizers minimized the intensity (1.8 m^2) and severity (9.42%) of malformed panicles. The nutrient deficiency may act as predisposing factor for malformation incidence. The increases in fresh and dry weight in malformed panicle might be due to fact that photosynthets accumulated higher rather its utilization. Application of Vermicompost (25kg) + Oil cake (2.5kg) enriched with Azotobacter + VAM + TV + PSB (100g each) registered higher fresh weight (104.7g) and dry weight (41.0g) with minimum intensity (2.2 m^2) and severity (12.15%) of malformation. Nitrogen content in malformed panicle was higher as it accumulates more instate of its utilization. The abnormality in nitrogen metabolism might be a cause of malformation. The interaction of chemical fertilizer and organic sources registered the minimum intensity (1.2 m^2) and severity (5.56%) of panicles malformation with recommended dose of chemical fertilizer. The maximum fresh (115.2g) and dry weight of malformed panicles (43.9g) was recorded with application of 520:160:450g NPK (125% of RDF) in combination of Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma viridi + PSB (100g each). Similar findings were noted by. Muhammad *at al.* (2007).

Macro and micro nutrient content in leaves

Incremental dose of nutrient in the form of chemical fertilizer increased the macro and micro nutrient content in leaves Table 2 and 3. Higher concentration of P in the leaves of shoots bearing healthy panicle than malformed, whereas the reverse trend was observed in case of N, K, Cu, Zn, Fe, and Mn. Higher content of nitrogen (2.33 and 2.58%), phosphorus (0.35 and 0.32%), potassium (58.39 and 71.46mg kg^{-1}), copper (8.77 and 9.75mg kg^{-1}), zinc (25.85 and 27.15mg kg^{-1}), iron (181.43 and 196.55mg kg^{-1}) and manganese (79.88 and 93.13 mg kg^{-1}) was recorded in the leaves of shoot bearing healthy and malformed panicles, respectively under the application of 125% of RDF (520:160:450g NPK $plant^{-1}$) over the leaves of unfertilized plant. Higher

Table 1: Influence of nutrient sources on intensity, severity, dry weight accumulation in healthy and malformed bearing shoots of Amrapali verity of mango under high density

Sl. No.	Treatments	Dry Matter Accumulation (g)		Intensity of Malformed panicle (m^2)	Severity of Malformed panicle (%)
		Healthy	Malformed		
F_1	Without fertilizer	22.6	39.9	4.0	25.97
F_2	NPK 310: 100: 270 g plant^{-1} (75% of RDF)	24.8	41.6	3.2	20.65
F_3	NPK 415: 130: 360 g plant^{-1} (100 % of RDF)	30.8	41.5	1.8	09.45
F_4	NPK 520: 160: 450 g plant^{-1} (125 % of RDF)	28.9	43.1	2.6	15.20
	S Em±	0.06	0.07	0.07	0.02
	C D at 5%	0.18	0.20	0.22	0.07
O_1	Oil cake 2.5 kg/plant	24.8	37.6	3.2	19.63
O_2	Azotobacter + VAM + *TV*, (100g plant^{-1} each)	23.4	36.8	3.6	23.53
O_3	Vermicompost (25 kgplant^{-1})	26.9	38.6	3.0	18.29
O_4	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1})	27.6	39.4	2.9	17.06
O_5	Vermicompost (25 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each) VC + AZT + VAM + TV	28.5	39.6	2.5	14.37
O_6	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each)	29.4	41.0	2.2	12.15
	S Em±	0.07	0.09	0.09	0.02
	C D at 5%	0.21	0.24	0.27	0.08

Table 2: Influence of nutrient sources on macro nutrient contents in healthy and malformed bearing shoots of Amrapali verity of mango under high density

Sl. No.	Treatments	Nitrogen (%)		Phosphorous (%)		Potassium (mg kg^{-1})	
		Healthy	Malformed	Healthy	Malformed	Healthy	Malformed
F_1	Without fertilizer	2.08	2.33	0.31	0.28	51.01	61.19
F_2	NPK 310: 100: 270 g plant^{-1} (75% of RDF)	2.17	2.44	0.32	0.29	52.59	65.75
F_3	NPK 415: 130: 360 g plant^{-1} (100 % of RDF)	2.28	2.50	0.34	0.30	55.20	67.76
F_4	NPK 520: 160: 450 g plant^{-1} (125 % of RDF)	2.33	2.58	0.35	0.32	58.39	71.46
	S Em±	0.10	0.12	0.006	0.11	0.40	0.39
	C D at 5%	0.28	0.34	0.17	NS	1.14	1.11
O_1	Oil cake 2.5 kg/plant	2.01	2.28	0.32	0.27	48.38	60.85
O_2	Azotobacter + VAM + *TV*, (100g plant^{-1} each)	1.94	2.11	0.29	0.25	46.59	55.12
O_3	Vermicompost (25 kgplant^{-1})	2.15	2.41	0.33	0.30	53.82	66.06
O_4	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1})	2.25	2.54	0.33	0.31	56.25	68.15
O_5	Vermicompost (25 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each)	2.43	2.69	0.35	0.32	59.44	73.18
O_6	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each)	2.52	2.73	0.36	0.33	61.31	75.89
	S Em±	0.12	0.15	0.007	0.014	0.49	0.48
	C D at 5%	0.34	0.42	0.020	0.039	1.39	1.36

Table 3: Influence of nutrient sources on micro nutrient contents in healthy and malformed bearing shoots of Amrapali variety of mango under high density

Sl. No.	Treatments	Copper (mg kg^{-1})		Zinc (mg kg^{-1})		Iron (mg kg^{-1})		Manganese (mg kg^{-1})	
		Healthy	Malformed	Healthy	Malformed	Healthy	Malformed	Healthy	Malformed
F_1	Without fertilizer	7.98	9.00	23.65	24.79	163.88	180.25	68.44	80.43
F_2	NPK 310: 100: 270 g plant^{-1} (75% of RDF)	8.17	9.27	24.32	25.96	171.56	185.57	72.57	86.88
F_3	NPK 415: 130: 360 g plant^{-1} (100 % of RDF)	8.58	9.56	25.16	26.64	171.56	190.98	74.02	87.88
F_4	NPK 520: 160: 450 g plant^{-1} (125 % of RDF)	8.77	9.75	25.85	27.15	181.43	196.55	79.85	93.13
	S Em±	0.07	0.13	0.14	0.18	0.82	1.26	1.55	0.50
	C D at 5%	0.20	0.36	0.40	0.53	2.35	3.62	4.45	1.44
O_1	Oil cake 2.5 kg/plant	7.88	8.95	23.16	24.21	159.58	176.48	70.49	80.59
O_2	Azotobacter + VAM + *TV*, (100g plant^{-1} each)	7.18	8.37	21.96	23.04	145.48	160.13	62.19	75.88
O_3	Vermicompost (25 kgplant^{-1})	8.26	9.04	24.58	25.30	170.88	188.73	71.92	86.83
O_4	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1})	8.79	9.78	25.47	26.66	177.39	194.38	73.76	90.14
O_5	Vermicompost (25 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each)	8.89	9.93	26.45	28.12	186.78	202.46	80.16	92.90
O_6	Vermicompost (25 kg plant^{-1}) + Oil cake (2.5 kg plant^{-1}) + Azotobacter + VAM + *Trichoderma viridi* (100g plant^{-1} each)	9.25	10.29	26.84	29.40	192.59	207.87	83.84	96.13
	S Em±	0.09	0.16	0.17	0.22	1.01	1.57	1.91	0.62
	C D at 5%	0.24	0.44	0.49	0.64	2.87	4.68	5.45	1.76

content of these nutrients might be due to fact that an application of NPK with increasing dose increases dry matter accumulation and nutrient concentration. The increase in uptake of these nutrients might be related to the development of root and plant canopy which accelerate the absorption of nutrients. These results are in close conformity with the findings of Singh *et al.* (2012).

Organic sources also brought about the significant change in the nutrient content of leaves of shoot bearing healthy and malformed panicles. Maximum content of nitrogen (2.52 and 2.73%), phosphorus (0.36 and 0.33%), potassium (61.31 and 75.89mg kg^{-1}), copper (9.25 and 10.29 mg kg^{-1}), zinc (26.84 and 29.40 mg kg^{-1}), iron (192.59 and 207.87 mg kg^{-1}) and manganese (83.084 and 96.13 mg kg^{-1}) was recorded when plant nourished with Vermicompost @ 25 kg and Oil cake (2.5 kg) enriched with Azotobacter + VAM + TV + PSB (each 100g). The higher concentration of macro and micro nutrient in leaves might be due to fact that, steady available of nutrients in vermicompost have resulted in increase uptake of nutrients by plants Rajkhowa *et al.* (2000). Chaudhary *et al.* (2003) who reported increase N, P and K content with application of vermicompost and farm yard manures. Hangarge *et al*. (2002) reported higher N, P and K content with the application of vermicompost and cow dung slurry. It was interesting of note that, when P was applied along with phosphorous solubilizing bacteria resulted increase, in uptake of phosphorus and Mg both. This is possibly due to the improvement in soil conditions as well as mineralization of salts, making them readily available to the plant system (Singh *et al.* (2012).

Application of organics bio-inoculants as well as chemical fertilizers positively increases the content of various nutrients in the leaves. The content of potassium (62.90 and 77.82mg kg^{-1}), zinc (27.33 and 30.03mg kg^{-1}), iron (196.93 and 213.10 mg kg^{-1}) and manganese (88.57 and 98.03mg kg^{-1}) was higher with 125 % recommended dose of NPK, while applied with Vermicompost (25 kg) + Oil cake (2.5 kg) + Azotobacter + VAM + Trichoderma and PSB (100g each) in leaves of shoot bearing healthy and malformed panicles, respectively. Higher N content may be attributed to an creation of favorable environment in the rhizosphere with respect to proper aeration and desired moisture level promote the microbial N fixation and mineralization of P due to active presence of responsible microbes. The addition of vermicompost and VAM promote root colonization through mycelial network of arbuscular mycorrhizal fungi, thus increased the surface area for nutrients and water absorption resulted in higher nutrient contents of leaf (Morselli *et al*. 2004; Gupta *et al.* 2005). Phosphorus is applied to soil through fertilizer get fix with the soil particles which is unavailable to the plant. The presence of phosphorus solubilizing micro-organisms released unavailable slowly and made available to the plant (Sundara *et al*. 2002). The increase in micro nutrient concentration in leaf might be due to the fact that vermicompost contain micronutrient in addition to macronutrients in available form (Prakash *et al*. 2002; Sen 2003).

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